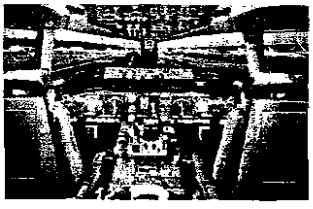
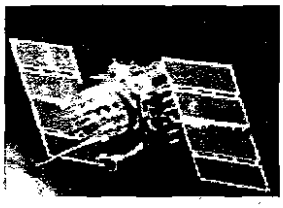
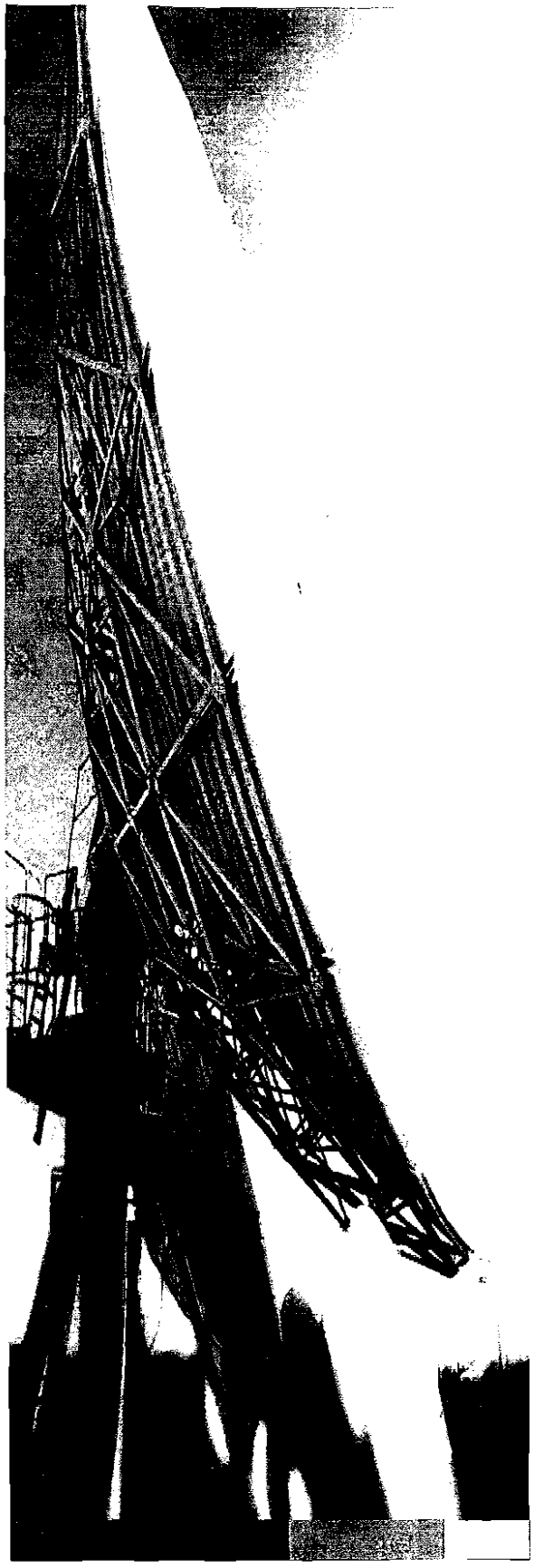
Performance Based Navigation – The Implementation Plan for Hong Kong


Civil Aviation Department

The information contained in this implementation plan may be subject to change without notice. For full details of the operational requirements, please refer to the current rules and regulations and the Hong Kong Aeronautical Information Publications.



Preface

The continuing growth of aviation increases demands on airspace capacity therefore emphasizing the need for optimum utilization of available airspace. With the support of advanced airborne equipment and satellite-based navigation technologies, improved operational efficiency derived from the application of area navigation (RNAV) techniques has resulted in the development of the concept of "**Performance Based Navigation (PBN)**" worldwide and for all phases of flight.

In line with the International Civil Aviation Organization (ICAO) Asia-Pacific Regional PBN Implementation Plan, the Hong Kong Civil Aviation Department (CAD) has adopted a 3-phased approach for the implementation of PBN :

- Short Term (2008-2012)
- Medium Term (2013-2016)
- Long Term (Beyond 2016)

This implementation plan has been developed to provide our aviation partners and all those who will be involved with some general information on the concepts of PBN and the PBN implementation plan in Hong Kong.

Should you have any comments or questions, please feel free to contact us.

Hong Kong CAD is committed to providing a safe and efficient air transport system in Hong Kong.

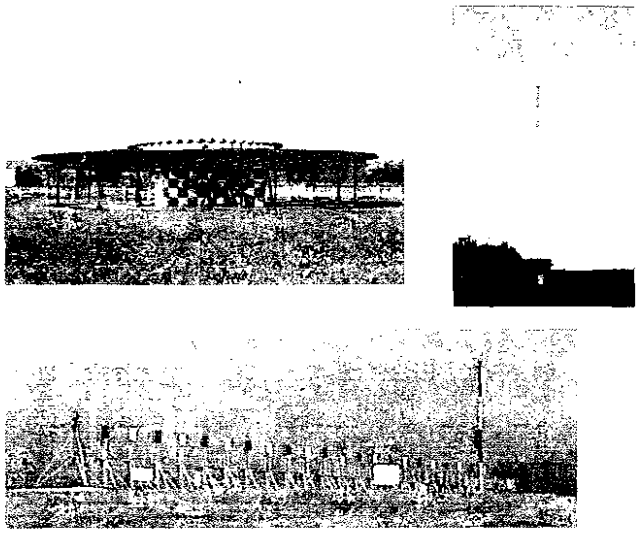
Norman Lo
Director-General of Civil Aviation

Contents

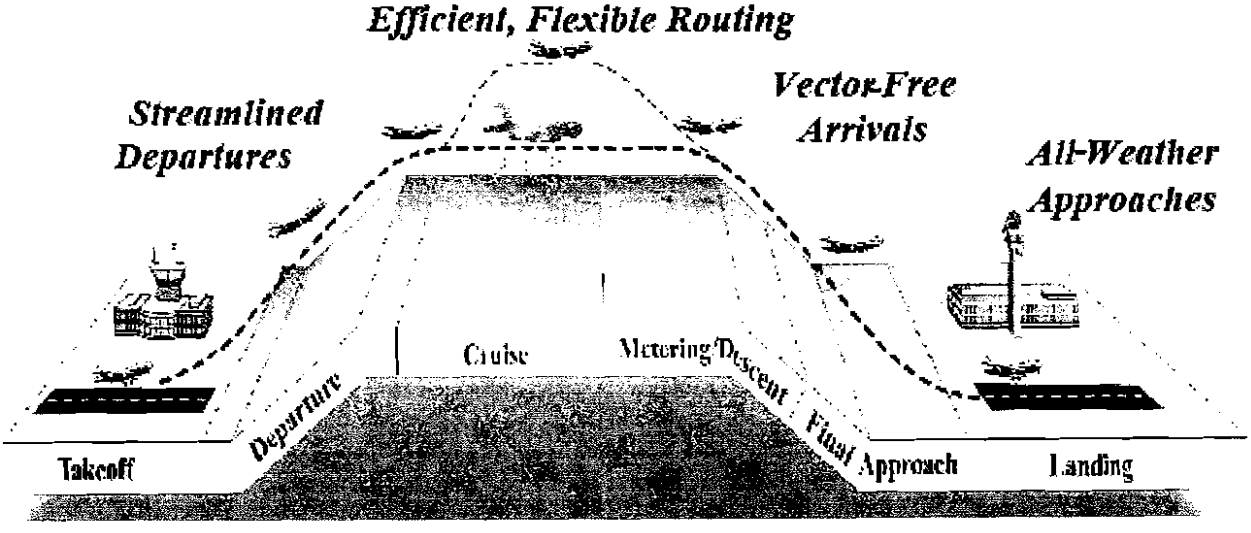
1. Background

The global aviation community is facing significant challenges in recent years. As demand for air transportation services continues to grow, we are faced with the challenge to safely increase capacity, efficiency and access to airports worldwide, particularly at terrain challenged airports. These constraints are largely a result of reliance upon conventional ground-based navigation aids (e.g. VHF Omni-directional Range (VOR), Non-directional Beacon (NDB), Instrument Landing System (ILS)), which limit routes and procedures to the physical locations of ground-based navigation aids. These ground-based systems have served the aviation community well since introduction; however, they do not permit the flexibility of point-to-point operations available with PBN to meet the challenges of today and the future.

To address these challenges, PBN is amongst the foremost efforts made by the aviation community worldwide.



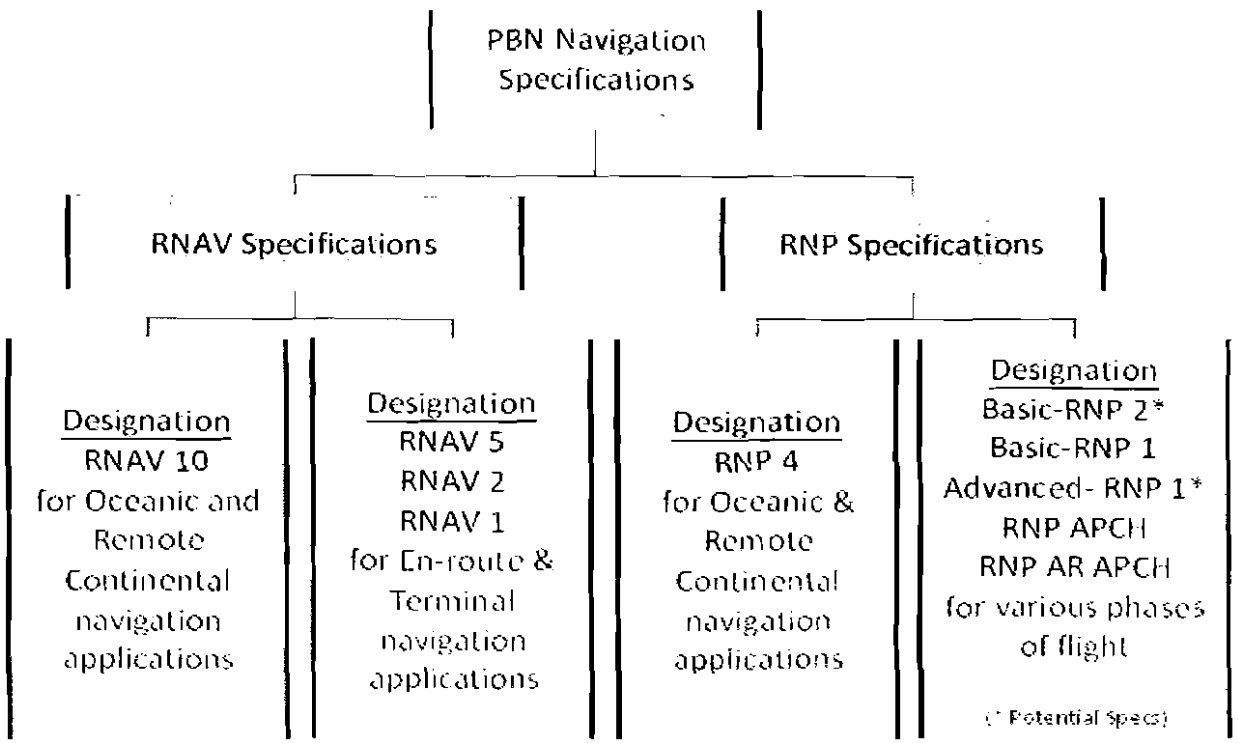
This implementation plan also outlines the benefits of PBN, the international requirements, the ongoing regional and international activities in facilitating PBN implementation as well as the Hong Kong CAD's PBN implementation plan.



What is PBN ?

PBN is a framework for defining performance requirements for aircraft operating along an air route, on an instrument approach or in a designated airspace. Through the application of Area Navigation (RNAV) and Required Navigation Performance (RNP) specifications, PBN provides a basis for the design and implementation of automated, optimized and environmental friendly flight paths as well as an enabler for efficient airspace design and refined protection against terrain.

The two main components of the PBN framework are :
RNAV and RNP



RNAV

RNAV enables aircraft to fly on any desired flight path within the coverage of ground- or space-based navigation aids, within the limits of the capability of the self-contained systems, or a combination of both capabilities. As such, RNAV aircraft have better access and flexibility for point-to-point operations.

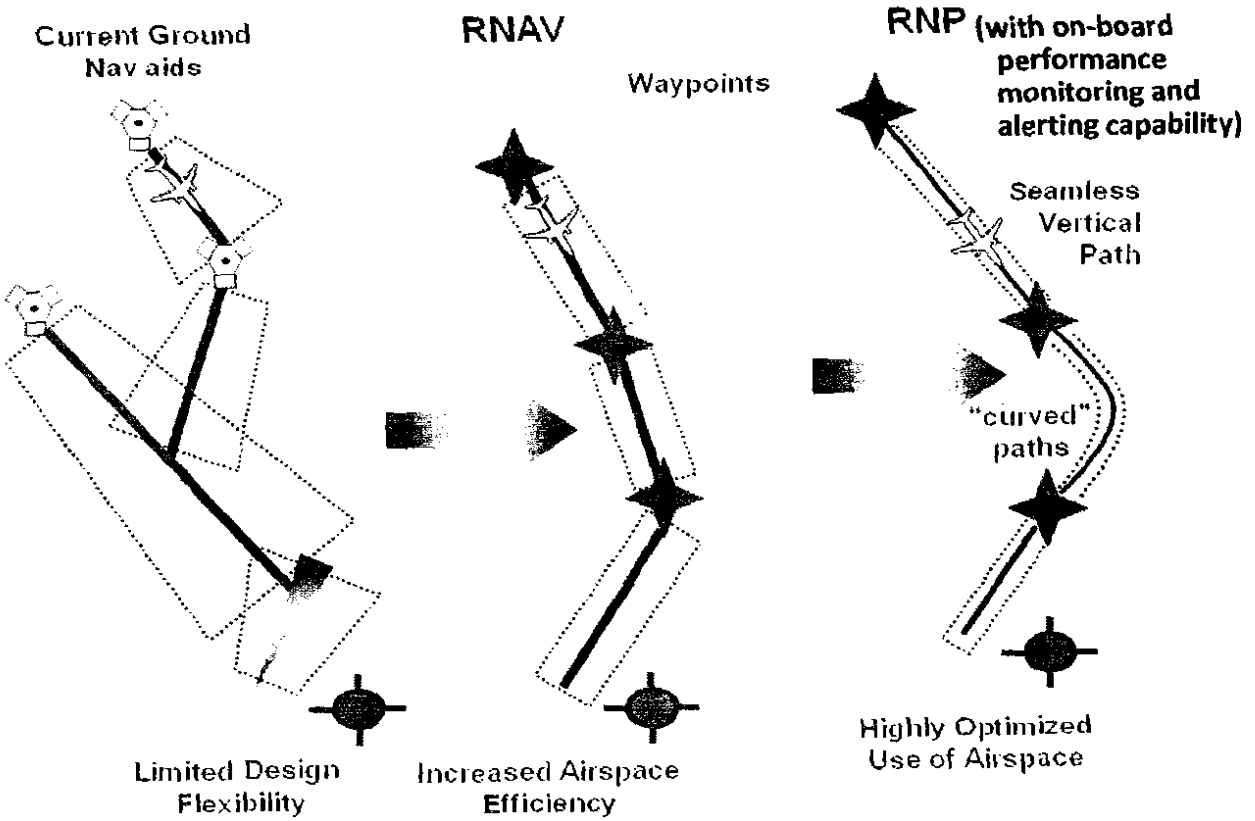
RNP

RNP is RNAV with the addition of an on-board performance monitoring and alerting capability. A defining characteristic of RNP operations is the ability of the aircraft navigation system to monitor the navigation performance it achieves and inform the crew if the requirement is not met during an operation. This onboard monitoring and alerting capability enhances the pilot's situational awareness and can enable reduced obstacle clearance or closer route spacing without intervention by air traffic control.

Certain RNP operations require advanced features of the onboard navigation function and approved training and crew procedures. These operations must receive approvals that are characterized as RNP Authorization Required (RNP AR) Operations.

The illustrations below depict the constraints associated with conventional, ground-based sensor specific routes/procedures and the flexibility and benefits of performance-based, non-sensor specific navigation (both RNAV and RNP).

Once the required performance level is established, the capability of the different aircraft determines whether it can safely achieve the specified performance and qualify for the operation.



2. Benefits of PBN

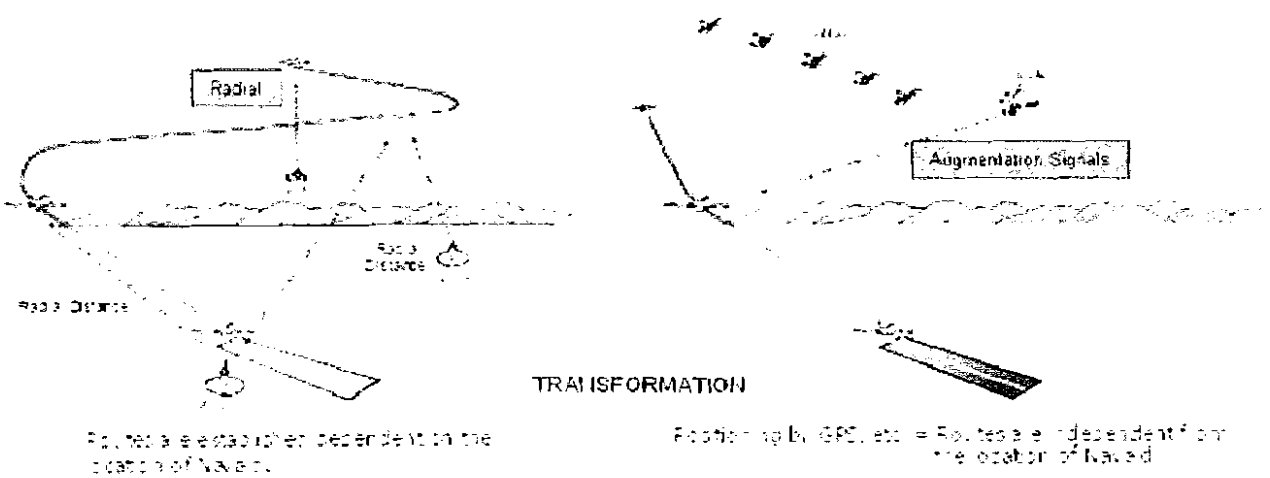
Since introduction, PBN is helping the global aviation community reduce aviation congestion, conserve fuel, protect the environment and maintain reliable, all-weather operations. It also provides air operators with greater flexibility and better operating returns while increasing the safety of air transport systems.

PBN Increases Airspace Capacity

- PBN increases airspace capacity through the implementation of more precise and efficient flight paths and air routes that will foster smoother traffic flows.
- It also helps to reduce congestion and delays in high-density airspace and airports by means of parallel routes and additional arrival and departure points in terminal areas.

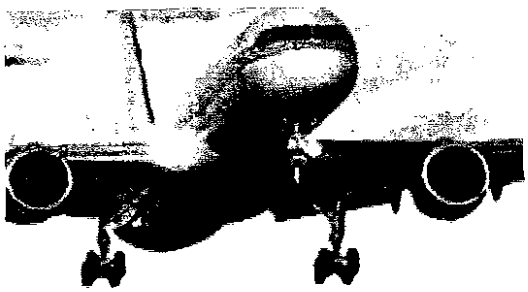
PBN Improves Accessibility and Operational Efficiency

- PBN reduces fuel consumption through shorter flight tracks, continuous descent procedures and fewer diversions. It enables more direct and closely spaced parallel tracks en route for increased fuel efficiency and reduced flight time variance.
- PBN improves the overall economic benefits of the operations by reducing navigation infrastructure investment and operating costs.
- PBN alleviates ATC and pilot workload by utilizing RNAV/RNP procedures and airborne capability and reducing the need for ground-to-air voice communications and radar vectoring.
- PBN creates new market opportunities by providing safe access to terrain and weather challenged destinations.

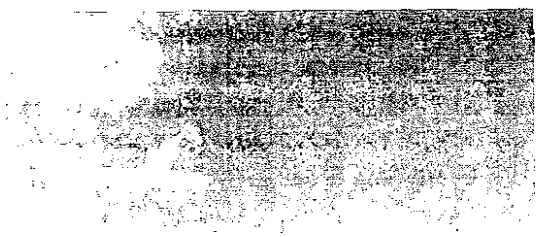


Conventional Route | **RNAV Route**

PBN Improves Safety



- PBN reduces the risk of Controlled Flight Into Terrain (CFIT) accidents by providing a very precise lateral and vertical flight path.
- It increases airspace safety through the implementation of continuous and stabilized descent procedures using vertical guidance.
- PBN also provides consistent, predictable and stabilized approaches, and improves airport and airspace arrival paths in all-weather operations.



PBN is Environment-Friendly

- PBN reduces emissions by saving fuel through shorter and vertically optimized PBN flight paths.
- PBN also reduces noise emission through the use of continuous descent procedures that allow aircraft to descend from high altitudes to the airport at minimum thrust settings.

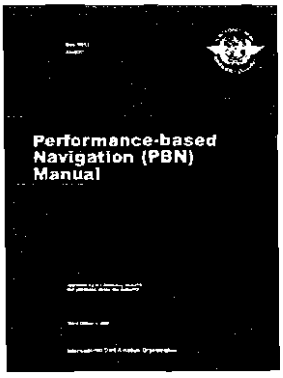
3. International Requirements

To reap the benefits offered by PBN and to ensure a globally harmonized and coordinated transition to PBN, the 36th Session of the ICAO Assembly adopted a Resolution (A36-23) to resolve that States and Planning and Implementation Regional Groups (PIRGs) should have in place a PBN implementation plan by 2009 to achieve :

1) implementation of RNAV and RNP operations (where required) for en-route and terminal areas according to established timelines and intermediate milestones; and

2) implementation of approach procedures with vertical guidance (APV) (through barometric vertical navigation (Baro-VNAV) and/or augmented Global Navigation Satellite System (GNSS)) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30% by 2010, 70% by 2014.

In this connection, guidance materials have been developed by ICAO, with the aim of providing practical guidance to the aviation community on how to implement the various PBN applications.

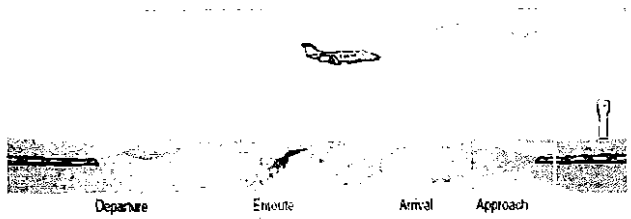


Use and scope of navigation specifications by flight phases

The table below shows the navigation specifications and their associated navigation accuracies published by ICAO for the various flight phases.

NAVIGATION SPECIFICATION	FLIGHT PHASE							
				APPROACH				
	En Route Oceanic / Remote	En Route Continental	ARR	Initial	Intermed	Final	Missed	DEP
RNAV 10 (RNP 10)	10							
RNAV 5		5	5					
RNAV 2		2	2					2
RNAV 1		1	1	1	1		1	1
RNP 4	4							
Basic-RNP 1			1	1	1		1	1
RNP APCH				1	1	0.3	1	
RNP AR APCH				1 - 0.1	1 - 0.1	0.3 - 0.1	1 - 0.1	

The above table also shows that for any particular PBN operation, it is possible that a sequence of RNAV and RNP applications may be used. For instance, a flight may commence in an airspace using a Basic-RNP 1 Standard Instrument Departure (SID), transit through en-route then oceanic airspace requiring RNAV 2 and RNP 4, respectively, and culminate with terminal and approach operations requiring RNAV 1 and RNP Approach (RNP APCH). The figure below is an example of an application of RNAV and RNP specifications to ATS routes and instrument procedures.

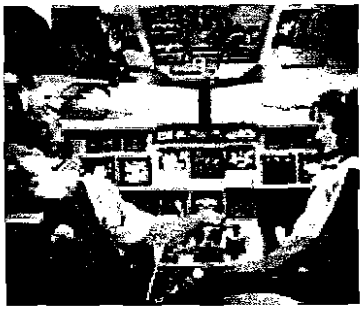


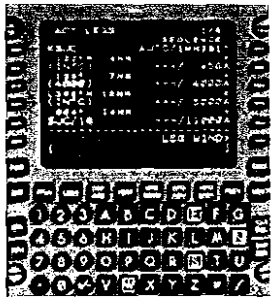
Operational Approval Process

It should be noted that before an aircraft or operator may conduct an RNAV / RNP operation, it must demonstrate compliance with the associated airworthiness and operational requirements as promulgated by the State of Registry / State of Operator, through the established regulatory or approval mechanism.

The following are amongst the areas requiring consideration and attention :

- Aircraft qualification and equipment capability
- Operating procedures for the navigation systems to be used
- Operator's navigation database
- Pilot knowledge, training and certification
- Operational approval process involved
- Oversight of operators





For more detail please refer to the ICAO PBN Manual – Doc 9613 or your respective Flight Operations Inspector for the necessary approval or authorization required.

4. Regional and International Cooperation

The Task Force has been active and effective in assisting the Asia-Pacific States in the implementation of PBN programmes and in ensuring the development of a regionally harmonized implementation plan. The Hong Kong CAD has been actively involved in The Task Force since its establishment.

Asia-Pacific PBN Task Force

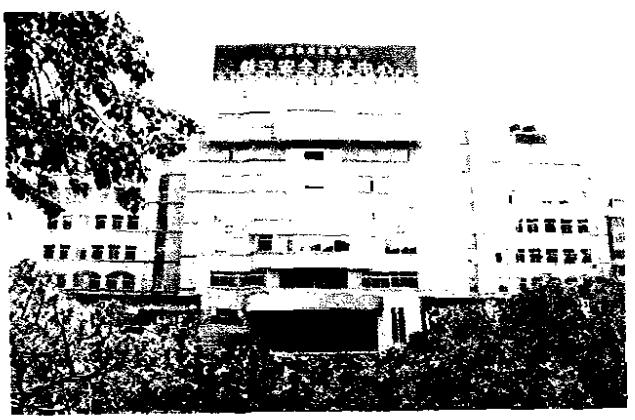
The implementation of PBN activities will require participation and the collaborative efforts of all stakeholders from the many disciplines involved.

To facilitate coordination between the Asia-Pacific States, a PBN Task Force was established in early 2008 to lead the region in the development of a regional PBN implementation plan and to address the various PBN implementation issues.

The Task Force, comprising representatives from ICAO, civil aviation administrations, air navigation service providers, airline and pilot associations, flight procedure design and operations experts, holds regular meetings to review the progress of PBN implementation in the region.

ICAO Flight Procedure Programme (FPP) Office

To further promote PBN implementation within the region and with the support and contribution of active participating States, Administrations and organizations, ICAO has, since March 2010, established an Asia-Pacific Flight Procedure Programme (APAC FPP) Office in Beijing. The objective is to enhance the safety and efficiency of air transport operations in a cost-effective manner, by enhancing the instrument flight procedure design capabilities of participating States or Administrations. In addition, the APAC FPP Office will also act as a regional forum to address the various instrument flight procedure design issues.

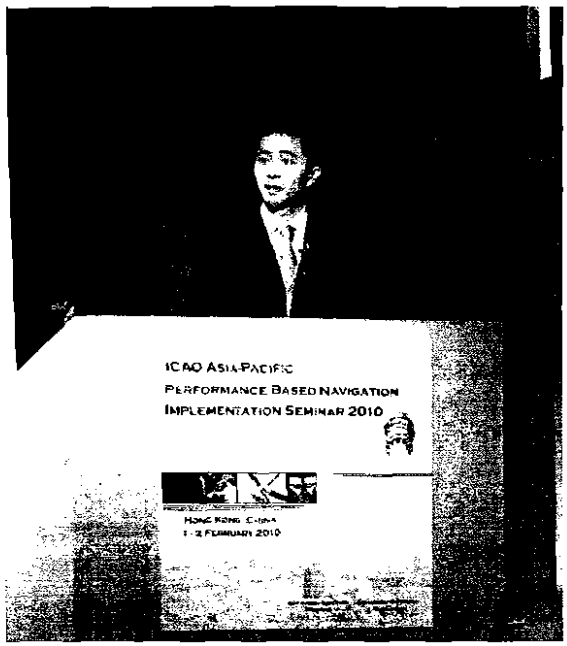


ICAO

Flight Procedure Programme

In support of this initiative of ICAO, Hong Kong has undertaken to participate in the ICAO APAC FPP as an "Active Participating State". In addition, Hong Kong is also committed to make available two of our most experienced flight procedure designers to the new APAC FPP Office for the provision of technical support and training of PBN procedure designers of other States in the Region.

Indeed the secondment arrangement is part of CAD's ongoing efforts to enhance airspace efficiency within the Hong Kong Flight Information Region. It is believed that the secondment arrangement will not only broaden the exposure of our flight procedure designers to the development and application of the latest advanced technologies in instrument flight procedure design, but will also provide us with the opportunity and experience to further enhance our instrument flight procedures at the Hong Kong International Airport and consolidate Hong Kong's position as an international and regional aviation hub.



Mr Mike Tam from the Hong Kong CAD speaking at the ICAO Asia-Pacific PBN Implementation Seminar held in Hong Kong on 1-2 February 2010. Under a secondment arrangement to the new ICAO APAC FPP Office, Mr Tam, who is an experienced air traffic controller and flight procedure designer, will provide technical support and training to PBN procedure designers of other States in the Asia-Pacific region.

5. Implementation of PBN in Hong Kong

PBN Planning and Implementation Team (PBN PIT)

To facilitate the development of a PBN implementation plan in Hong Kong and to ensure harmonization of PBN implementation between various aviation stakeholders, the Hong Kong PBN Planning and Implementation Team (PBN PIT) was established in November 2007.

The PBN PIT comprises representatives from the various disciplines of aviation including air navigation service providers, flight procedure designers, airspace planners, flight operations and airworthiness experts, airline operators, airline and pilot associations, etc.

The PBN PIT meets regularly to review and keep track of the latest PBN development and monitor the local implementation progress.

Implementation Plan in Hong Kong

In line with the ICAO Asia-Pacific Regional PBN Implementation Plan, Hong Kong adopts a 3-phased approach in the implementation of PBN :

- Short Term (2008-2012)
- Medium Term (2013-2016)
- Long Term (Beyond 2016)

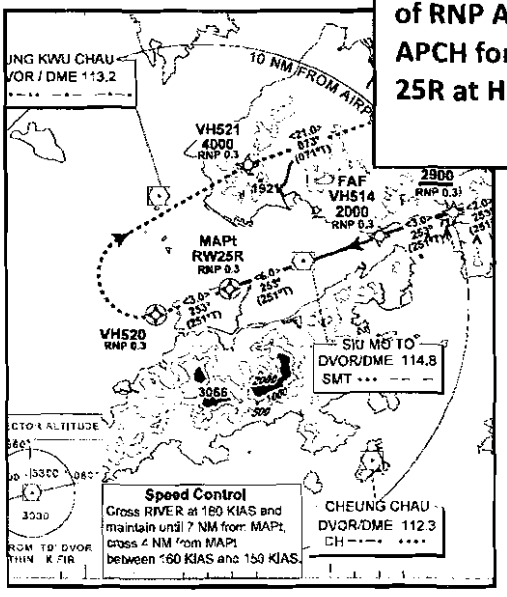
Tangible Benefits of PBN Implementation in Hong Kong

When ILS equipment is unserviceable or under maintenance, VOR approach, which is a demanding procedure requiring step descent and high cockpit workload, is the only backup instrument approach procedure available to aircraft. The RNP AR approach procedure serves as additional backup approach procedure to ILS. When ILS approach is not available, instead of flying the VOR procedure, aircraft can choose to fly the RNP AR approach with continuous descent and the procedure helps in reducing cockpit workload. Safety is thus enhanced. Hong Kong has implemented the RNP AR approach procedure to the north runway in June 2010.

Having implemented the RNP AR approach procedure to the north runway in June 2010, Hong Kong is now studying the introduction of RF turn in departure procedure so as to enhance track keeping accuracy of departing aircraft during the turn to reduce unnecessary noise disturbance to residential areas close to the flight path.

With the implementation of 50 NM longitudinal separation on PBN air routes L642 and M771 in 2008, the capacity of these two air routes has been increased to accommodate more flights. Hong Kong will conduct feasibility study on the implementation of RNP 4 on these 2 routes so as to further enhance the air route capacity.

Introduction of RNP AR APCH for RWY 25R at HKIA



Short Term (2008-2012)

Within the Approach Airspace, Hong Kong aims at achieving 100% implementation of RNP AR APCH procedures by 2012.

Whilst for the Terminal Airspace, Hong Kong will redefine all RNP 1 SIDs to RNAV 1 specification and aim to achieve 100% implementation of RNAV 1 Standard Terminal Arrival Routes (STARs) in the terminal airspace by 2012 after the successful implementation of RNP 1 SID in 2005.

In the En-route Airspace, Hong Kong aims at conducting trial operations for RNP4 on L642 and M771 by 2012 with an objective to implement RNP 4 by 2014. Within 2010, Hong Kong plans to issue a mandate for RNAV 1 and RNP 4 capability for the terminal airspace and the en-route airspace respectively.

AIRSPACE	SHORT TERM (2008-2012)
Approach	• Implement RNP AR APCH Procedure to North RWY by 2010 *[Implemented]* • Implement RNP AR APCH Procedure to South RWY by 2012 • Feasibility study of GBAS
Terminal (SID/STAR)	• Redefine all RNP1 SID to RNAV1 specification in 2010 (RNP1 SIDs implemented in 2005) • Implement RNAV1 STARs • Within 2010, issue mandate for RNAV1 capability within HK TMA by 2013
Enroute	• Apply 50NM Longitudinal Separation on RNP10 Routes in 2008 *[Implemented]* • Trial operation for RNP4 on L642 & M771 by 2012 • Within 2010, issue mandate for RNP4 capability within HK en-route airspace by 2014

Medium Term (2013-2016)

Within Approach Airspace, Hong Kong plans to issue a mandate for appropriate Navigation Specification, e.g. Advance RNP APCH, in 2013.

Within the Terminal Airspace, Hong Kong plans to achieve 100% RNAV 1 application by 2013.

For the En-route Airspace, Hong Kong aims at achieving 100% RNP 4 implementation by 2014.

AIRSPACE	MEDIUM TERM (2013-2016)
Approach	• Trial of GBAS for capable aircraft/operators • Consider use of appropriate Nav. Spec., e.g. Advance RNP APCH, within approach airspace

Terminal (SID/STAR)	• Implement RNAV1 application in TMA Airspace
	  • Mandate RNAV1 application for aircraft operating within TMA by 2013
	  • Achieve 100% RNAV1 SID/STAR in TMA

Enroute	• Implement RNP4 within enroute airspace
	  • Mandate RNP4 application for aircraft operating within en-route airspace by 2014
	  • Achieve 100% RNP4 within en-route airspace

Long Term (Beyond 2016)

Within the Approach Airspace, Hong Kong aims at achieving 100% implementation of the Navigation Specification selected in Medium Term by 2016 or beyond.

Within the En-route Airspace, Hong Kong will consider mandate better navigation specification in accordance with the ICAO regional roadmap.

To date, Hong Kong has been following the Plan closely in moving forward the PBN project and the implementation progress is satisfactory.

Hong Kong will continue its efforts in the implementation of PBN with a view to improving the overall operational efficiency and safety standards.

AIRSPACE	LONG TERM (BEYOND 2016)

Approach	• Subject to satisfactory results of the trial, consider GBAS as backup to the ILS
	• Consider use of other Nav. Spec. that suits the operation in HK.
	  • Consider mandate the Nav. Spec. selected for aircraft operating within approach airspace by 2016+
	  • Achieve 100% implementation of the Nav. Spec. selected within approach airspace

Enroute	• Consider mandate better navigation specification in accordance with the ICAO regional roadmap, e.g. RNP2

6. Communications, Navigation and Surveillance (CNS) Infrasturcture and Transition Strategies

The existing CNS infrastructure

Communication System

Currently, Hong Kong utilizes VHF for ground-to-air communications between the air traffic controllers and pilots. HF will be used as backup and for long range SAR services.

Navigation

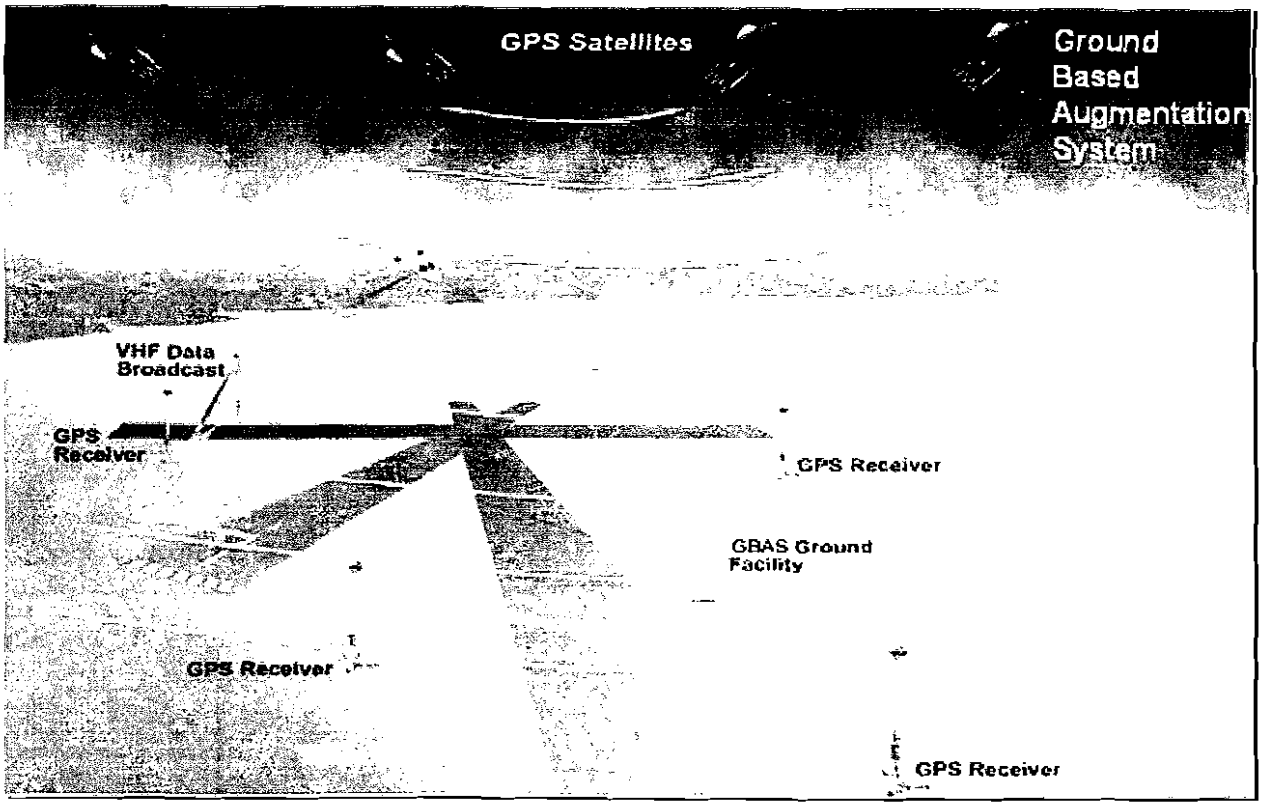
The conventional ground-based navigation aids, such as the VOR, ILS and DME, are used to provide navigational guidance to aircraft. NDB is also available to serve the missed approach procedure.

Surveillance

For surveillance, radar is the main surveillance system used in Hong Kong.

Future Plan

Whilst VHF and radar will still remain as the main communication and surveillance system to be used in Hong Kong in conjunction with the



implementation of PBN, Automatic Dependent Surveillance – Broadcast (ADS-B) will be implemented to supplement the radar surveillance, for instance, in the en-route airspace and also for low level airspace coverage.

In respect of air navigation, GNSS will replace the conventional navigation aids and be used as the major navigation aid for aircraft navigation within the terminal area. A feasibility study will be conducted in the near term to assess the applicability of Ground Based Augmentation System (GBAS) at the Hong Kong International Airport.

Subject to the result of the feasibility study, the new generation of GBAS flight procedures will gradually be developed and introduced to serve as backup approach procedure to ILS at the Hong Kong International Airport.

Transition Strategies to PBN Procedures

During transition to PBN, sufficient ground infrastructure for conventional navigation systems will be available. After the implementation of new Navigation Specification, operators will be given reasonable prior notification to allow them to equip appropriately to attain the required navigation performance.

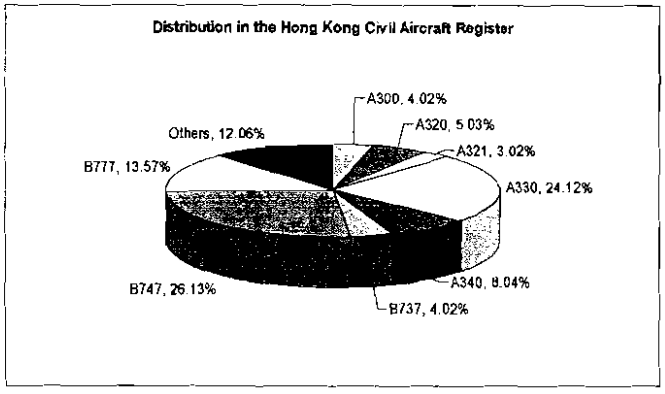
In the long term, examination of phasing out of NDB and other ground infrastructure in Hong Kong will be considered. The decommissioning of existing ground infrastructure will be done with caution to ensure that safety is not compromised. Consultation with other stakeholders and safety assessment will be conducted through the Hong Kong PBN Planning and Implementation Team (PIT).

7. PBN Readiness of Hong Kong Register Aircraft

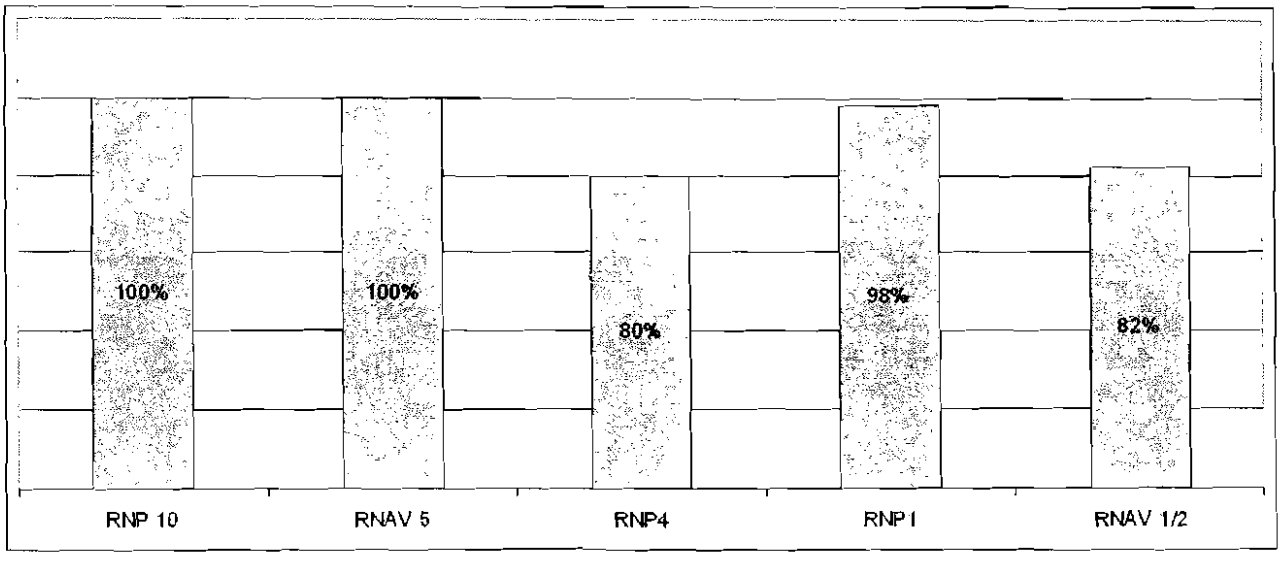
Aircraft Type	Number
Airbus A300	8
Airbus A320	10
Airbus A321	6
Airbus A330	48
Airbus A340	16
Boeing B737	8
Boeing B747	52
Boeing B777	27
Others	24

Aircraft Register

As at March 31, 2009, the total number of civil aircraft in the Hong Kong Civil Aircraft Register was 223. Of which 199 were registered under Hong Kong AOC holders.



Hong Kong Operators PBN Approval Status



8. Safety Assessment

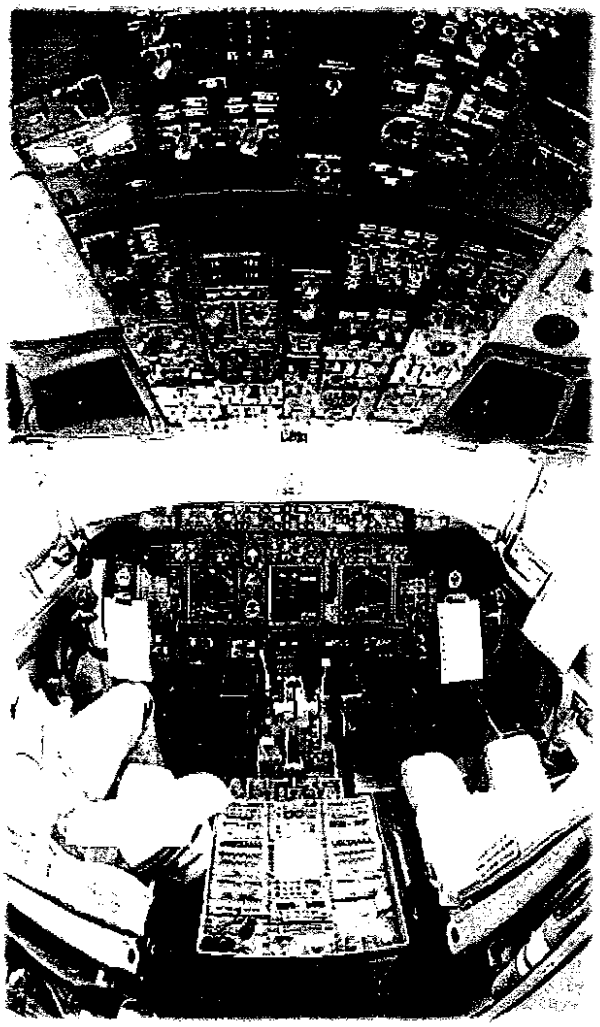
Safety Assessment

The implementation of PBN procedures will only take place after completion of a safety assessment to ensure that safety is not compromised and highest level of safety is achieved as far as reasonably practicable. In undertaking a safety assessment for the implementation of PBN, Hong Kong will:

1. Establish and maintain a database of PBN approvals for Hong Kong registered aircraft;
2. Pre-implementation – conduct safety assessments for PBN implementation in terminal and approach airspace;
3. Post-implementation – conduct review, if necessary, after implementation of PBN procedures.

Hong Kong has in place the Safety Management System Manual and Safety Management System Procedure Handbook. Before the implementation of the RNP approach procedure, safety assessment in accordance with the procedure laid down in the 2 manuals was completed by the Hong Kong PBN PIT. Post implementation review will normally be conducted 6 months after the implementation.

For safety assessment for En-route PBN implementation, Hong Kong will coordinate with adjacent States and, when required, request assistance from ICAO to ensure harmonization of regional implementation.



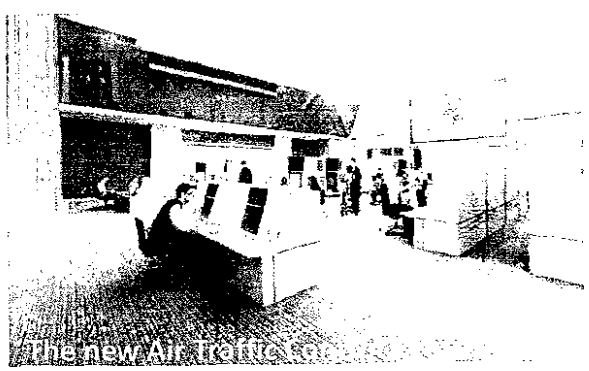
9. Way Forward

We value your comments and cooperation

In May 2009, CAD commenced the construction of our new Headquarters located at the southeast corner of the Airport Island. In the new Headquarters complex, there will be a new Air Traffic Control Centre that will accommodate a new state-of-the-art air traffic management (ATM) system. Sustainability, environmental friendliness and centre of excellence in aviation training are the main design themes of the new CAD building.

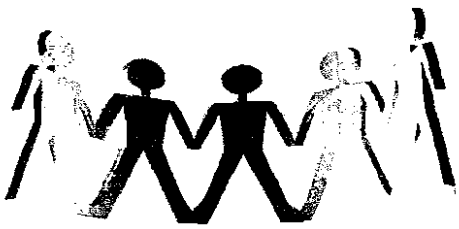
The new CAD Headquarters

With the state-of-the-art ATM system, enhanced airspace management, efficient flight procedures and a competent and robust workforce, we shall be able to meet the foreseeable future demands of the rapidly growing aviation industry.



The new Air Traffic Control

The goal towards building a seamless sky can only be achievable by the active collaboration and participation of all stakeholders. For this very reason, your cooperation and contributions are of vital importance to ensuring a regionally harmonized and coordinated transition to PBN.



Useful information on the development of PBN is also available on the following websites:

ICAO PBN	:	www.icao.int/pbn
Hong Kong PBN	:	www.pbninfo.gov.hk

Should you have any questions or comments on the information contained in this implementation plan, please feel free to contact us via the following email address or fax number:

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